

**A Description of the Larva of *Ceratophyus gopherinus*
Cartwright with a Revised Key to the Larvae of North
American Geotrupini and Notes on the Biology¹**
(Coleoptera: Scarabaeidae)

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In 1962, a strange, deep burrowing, geotrupid beetle was found in Santa Barbara County, California, which could be of economic importance in golf courses and lawns (Anonymous, 1963). It was described as a new species of *Ceratophyus* by Cartwright in 1966. *Ceratophyus* is an old world genus occurring from Morocco and Southwestern Europe to Siberia, South Russia, and Sikkim (Cartwright, 1966). It seems probable, therefore, that *Ceratophyus gopherinus* is a species of foreign origin that was introduced into California some 10 years ago.

The larvae of *Peltotrupes youngi* Howden, of *Mycotrupes gaigei* Olsen and Hubbell, and of several species of *Geotrupes* were described by Howden (1952, 1954, 1955, 1964). In 1967 Howden described the larva of a Mexican species, *Ceratotrupes bolivari* Haeffter and Martinez. In 1955 he gave a key to the genera known at that time. The larvae of several species of *Geotrupes* were described by Ritcher (1947, 1966) together with keys to the known genera of Geotrupini.

Robert Duff discovered the larva of *Ceratophyus* in February 1970. This is the only genus of Geotrupini now occurring in North America whose larva was unknown.

CERATOPHYUS GOPHERINUS Cartwright, Third-Stage Larva

Description based on 12 third-stage larvae collected by Robert Duff from cells deep in the soil 8, 14, and 22 February 1970, at Vandenburg Village, Santa Barbara County, California.

Maximum width of head (Fig. 1) 4.14 to 4.86 mm with a mean width of 4.42 mm. Surface light yellow brown to light red brown, finely granulose. Frons, on each side, with one or two posterior frontal setae, one or two setae in each anterior angle, one exterior frontal seta, and one anterior frontal seta. Clypeofrontal suture absent. Epicranial stem continued on frons past juncture of frontal sutures. Epicranium, on either side, with an oblique row of 3 or 4 setae.

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Labrum wider than long, with slightly trilobed anterior margin; lateral lobes broadly rounded, sides constricted toward base.

Antenna 3-segmented but distal segment very small, cap-like. Segment 2 with a distal, ovate, sessile sense organ (Figs. 1, 7, 8).

Scissorial area of each mandible with a blade-like anterior portion and a posterior tooth. Inner margin of each mandible, between scissorial area and molar region, with prominent process; process bifurcate on left mandible (Fig. 3). Molar areas asymmetrical, left mola overhung dorsally by prominent acia; grinding surface of left mandible concave, that of right mandible rather flat.

Maxilla (Fig. 4) with separate galea and lacinia. Lacinia with 3 apical unci. Stipes with sparsely set row of 8 to 12 short, conical, stridulatory teeth. No stridulatory teeth on palpifer.

Hypopharynx (Fig. 5) with asymmetrical oncyli, more strongly developed on the right. Glossa broadly rounded, not emarginate.

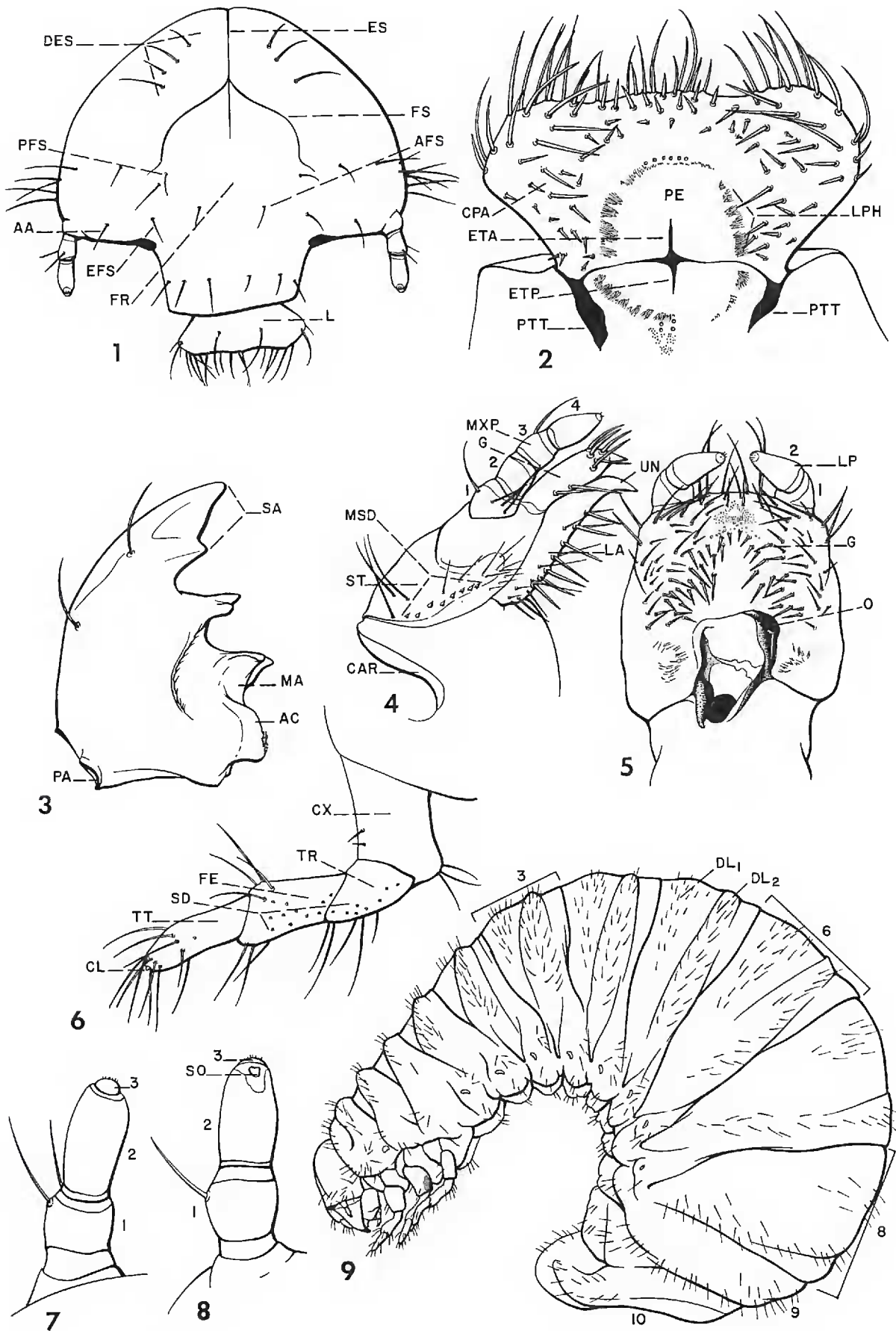
Epipharynx (Fig. 2) very similar to that of *Peltotrupes youngi* Howden. Hapteromerum inconspicuous, bare, mound-like. Each chaetoparia sparsely set with about 20 to 25 slender chaetae of varying lengths, most directed mesad. Pedium bare, surrounded anteriorly and laterally by phobae. Each lateral phoba a dense row of short blunt filaments. Anterior phoba row of shorter filaments and with curved row of 6 macrosensilla along its anterior margin. Haptolachus with curved phoba on right side and smaller curved phoba on the left. Torma slightly asymmetrical, united mesally and with thin posterior and anterior epitormae on the midline. Pternotormae prominent, that on right larger.

Spiracles reniform (Fig. 9); emargination of prothoracic spiracle facing ventrad, emarginations of abdominal spiracles cephaloventrad. Spiracles on abdominal segments 1-6 similar in size, those on segments 7-8 progressively smaller.

Abdomen bluish, greatly swollen posteriorly as in *Peltotrupes* and with protruding anal lobes on each side of last segment (Fig. 9). Dorsal lobes inconspicuous, two in number on segments 1-8. Dorsal lobe 1 much broader, especially on abdominal segments 3-8. Last (tenth) abdominal segment short, obliquely flattened, with bare whitish, fleshy anal lobes (Fig. 9). Anal opening bordered dorsally by flap-like lobe (Fig. 10). Endoskeletal figure, below dorsal lobe, triangular, sides converging toward anal opening. Impressed area lateral of anal opening surrounded by same pigmented line that defines posterior endoskeletal figure. Each impressed area with curved dorsal arm expanded apically, and smaller, curved, lateral arm which tapers to a point (lateral lobes not separated from ventral anal lobes by impressed lines).

Legs 4-segmented with some segmental boundaries poorly defined. All three pairs of legs well developed, metathoracic legs smallest (Fig. 9). Small claws on all legs, smallest on metathoracic legs. Metathoracic legs with stridulatory tubercles on inner face of trochanter and femur (Fig. 6), and one or two tubercles on tibio-tarsus. Stridulatory structure on mesothoracic legs consisting of faintly striated area on outer surface of each coxa.

Ceratophyus gopherinus, based on larval characters, represents a distinctly different genus which is not closely related to *Ceratotrupes*. The less specialized metathoracic legs and the fusion of the anal and ventral lobes of the last abdominal segment distinguish it from larvae of



FIGS. 1-9. Larva of *Ceratophyus gopherinus* Cartwright. FIG. 1. Head. AA, seta of anterior frontal angle; AFS, anterior frontal seta; DES, dorsoepicranial setae; EFS, exterior frontal seta; ES, epicranial suture; FR, frons; FS, frontal suture; L, labrum; PFS, posterior frontal setae. FIG. 2. Epipharynx. CPA, chaetoparia;

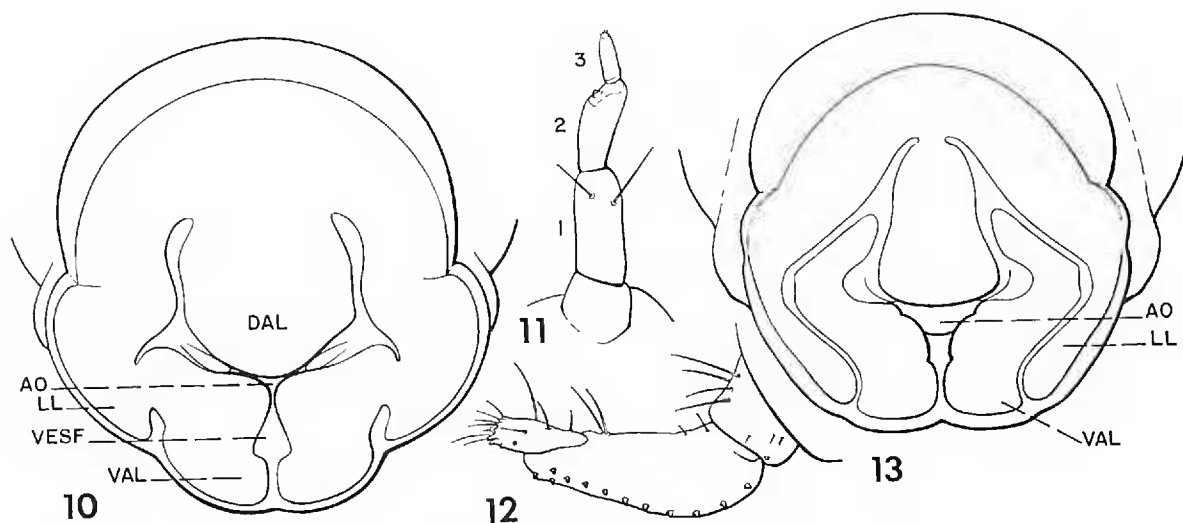


FIG. 10. *Ceratophyus gopherinus*. Caudal view of last abdominal segment. AO, anal opening. DAL, dorsal anal lobe; LL, lateral lobe; VAL, ventral anal lobe; VESF, ventral part of endoskeletal figure. FIG. 11. *Geotrupes blackburnii excrementi* Say. Dorsal surface of right antenna. FIG. 12. *Peltotrupes youngi*. Inner surface of metathoracic leg. FIG. 13. *Peltotrupes youngi*. Caudal view of last abdominal segment. AO, anal opening; LL, lateral lobe; VAS, ventral anal lobe.

other North American Geotrupini. In common with the larva of *Peltotrupes*, *Ceratophyus* has a greatly swollen body, much reduced last antennal segment, and similar epipharyngeal characters.

The following key (in part from Howden, 1954, 1955, and 1967) can be used to separate the larvae of North American Geotrupini. Larvae of the three genera, *Ceratotrupes*, *Geotrupes*, and *Mycotrupes*, are very closely related. The characters used to separate them in the key represent differences which are often found in species belonging to the same genus.

KEY TO LARVAE OF THE GENERA OF GEOTRUPINI
FOUND IN NORTH AMERICA

- 1. Last antennal segment greatly reduced in size, cap-like (Figs. 1, 7, 8);
abdomen greatly swollen (Fig. 9) 2

←

ETA, anterior epitorma; ETP, posterior epitorma; LPH, laeophoba; PE, pedium; PTT, pternotorma. FIG. 3. Dorsal surface of left mandible. AC, acia; MA, molar area; PA, preartis; SA, scissorial area. FIG. 4. Inner surface of left maxilla. CAR, cardo; G, galea; LA, lacinia; MSD, maxillary stridulatory teeth; MXP, maxillary palpus; ST, stipes. FIG. 5. Labium with hypopharynx. G, glossa; LP, labial palpus; O, oncyclus. FIG. 6. Inner surface of right metathoracic leg. CL, claw; CX, coxa; FE, femur; SD, stridulatory teeth; TR, trochanter; TT, tibiotarsus. FIG. 7. Ventral surface of right antenna. FIG. 8. Dorsal surface of left antenna. SO, sense organ. FIG. 9. Left lateral view of entire larva.

- Last antennal segment reduced in size but subconical or cylindrical in shape, usually one fourth as long as second segment (Fig. 11); abdomen moderately swollen 3
2. Metathoracic legs not greatly reduced in size (Figs. 6, 9), claws present on all legs *Ceratophyus*
 Metathoracic legs greatly reduced in size (Fig. 12), claws absent on all legs *Peltotrupes*
3. Epipharynx with poorly developed pternotormae *Mycotrupes*
 Epipharynx with well developed pternotormae 4
4. Endoskeletal figure of ventral anal lobe poorly defined *Ceratotrupes*
 Endoskeletal figure of ventral anal lobe laterally expanded with sharp, fairly truncate angles *Geotrupes*

BIOLOGY

In January 1962, Stanley Trujillo, County Agricultural Inspector for Santa Barbara County, reported the presence of a new pest species identified as *Ceratophyus* sp. by Cartwright, from an area 6 miles north of Lompoc, California (California Dept. of Agr. Rept. 62-3, courtesy of George Okumura; Cartwright, 1966). The presence of sand mounds 7.5 to 15 cm high above the burrows was reported to be "inconvenient" on lawns and golf courses. The beetle was abundant in scrub oak thickets on the Vandenberg Air Force Base.

In 1962, damage to lawns of model homes in the Vandenberg Air Force base village was reported (Anonymous, 1963). Adults were trapped in cans baited with Japanese beetle bait (anethole-eugenol) and with ammonium carbonate. Depths of "nests" were 1.8 to 2.4 m, deeper than in 1962 (Anonymous, 1963).

Three trips were made (8, 14, and 22 January 1970) to study *Ceratophyus* biology at Vandenberg Village where two excavations were investigated in a chaparral plant community consisting of *Quercus* sp., *Adenostoma fasciculatum* Hook and Arn., *Arctostaphylos* spp., and *Ceanothus* sp. In addition, a third site was studied where the ground cover was composed primarily of *Adenostoma*.

Ceratophyus burrows were marked at the soil surface either by mounds of sand or, occasionally, by "ropes" of sand. Early in the morning "ropes" or mounds of darker colored, moist sand were frequently seen on top of or to the side of the existing mounds but within a few hours many of the "ropes" dried out and crumbled. Presence of fresh, moist sand in the early morning indicated that the adults were active at night. The burrows extended downward, with twists and turns, to a depth of about 1.5 m. They then bent sharply at a horizontal plane. The horizontal portion was enlarged into a chamber 20 to 45 cm long which was filled with dry surface sand, leaf litter, and twigs apparently provisioned

by the adults. On several occasions both a male and female were found together in a horizontal chamber. The food material provided for the larvae by the adult beetles was leaf litter and small twigs of *Adenostoma*, *Arctostaphylos*, *Ceanothus*. It appears that the beetles are not particular about the type of leaf litter they carry into their burrows.

A total of 13 third-stage larvae were collected from cells, at depths of from 1 to 1.5 m. The cells were 12.5 to 20 cm long and from 2.5 to 3.75 cm in diameter, lying in a horizontal or slightly inclined position. Many contained moist, decayed leaf material and numerous small twigs. As the larvae feed on the food provisioned by the adults they apparently construct cells from their fecal pellets in a manner similar to that of *Peltotrupes* larvae (Howden, 1952). This habit probably serves to keep out sand and conserve moisture.

ACKNOWLEDGMENT

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